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Document Name: SAE J231: Minimum Performance Criteria for Falling Object Protective Structures (FOPS)

CFR Section(s): 30 CFR 77.403(a)

Standards Body: Society for Automotive Engineering

APPROVED

Official Incorporator:

The Executive Director
OFFICE OF THE FEDERAL REGISTER
WASHINGTON, D.C.

MINIMUM PERFORMANCE CRITERIA FOR FALLING OBJECT PROTECTIVE STRUCTURE (FOPS)—SAE J231 SAE Recommended Practice

Report of Construction and Industrial Machinery Technical Committee approved May 1971.

1. *Objective*—This SAE Recommended Practice establishes minimum performance requirements for structures intended to provide operators with reasonable protection from such falling objects as trees and rocks. This applies only to vehicles covered by SAE J320, J394, J395, and J396.

2. *Scope*—The minimum performance requirements are based on the performance of experience-proved structures in consistently repeatable laboratory evaluations. These evaluations are for both resistance to localized impact penetration and gross load carrying capability. It is intended that all portions of this recommended practice shall be reviewed and revised as additional knowledge of FOPS performance becomes available.

3. *Facilities and Apparatus*

3.1 Facilities

3.1.1 A standard laboratory drop test object, made of steel, as shown in Fig. 1:

3.1.2 A means of raising the standard object to the required height.

3.1.3 A means of releasing the standard object so that it is dropping without restraint.

3.1.4 A surface of such firmness that it shall not be penetrated by the vehicle or test bed under the loading of the drop test.

3.1.5 A means of determining if the FOPS enters the critical zone (SAE J397) during the drop test. This may be either of the following:

3.1.5.1 A critical zone, in the upright attitude, made of a material which will indicate any penetration by the FOPS. Grease may be put on the lower surface of the FOPS cover to indicate such penetration.

3.1.5.2 A dynamic instrumentation system of sufficient frequency response to indicate the pertinent deflection with respect to the critical zone.

3.2 Apparatus

Means to Measure	Accuracy
Deflection of FOPS	±5% of deflection measured
Test weight	±5% of weight measured
Dimensions of critical zone	±0.5 in (±12.7 mm)

4. *Vehicle or Test Bed Condition*

4.1 The FOPS to be evaluated must be attached to the vehicle structure as it will be in actual vehicle use. A complete vehicle is not required; however, the portion to which the FOPS is mounted must be identical to the actual structure, and the vertical stiffness of a test bed must be not less than that of an actual vehicle as described in paragraph 4.2.

4.2 If the FOPS is mounted on a vehicle, the following stipulations apply:

4.2.1 There are no limitations on customary attachments and/or payload.

4.2.2 All ground engaging tools shall be in normal carry positions.

4.2.3 All suspension systems, including pneumatic tires, shall be set at operating levels. Variable suspensions shall be in the "hard" range.

4.3 All cab elements, such as windows, normally removable panels, or nonstructural fittings, are to be removed so that they do not contribute to the strength of the FOPS.

5. *Drop Test Procedure*

5.1 The standard laboratory drop test object (Fig. 1) shall be

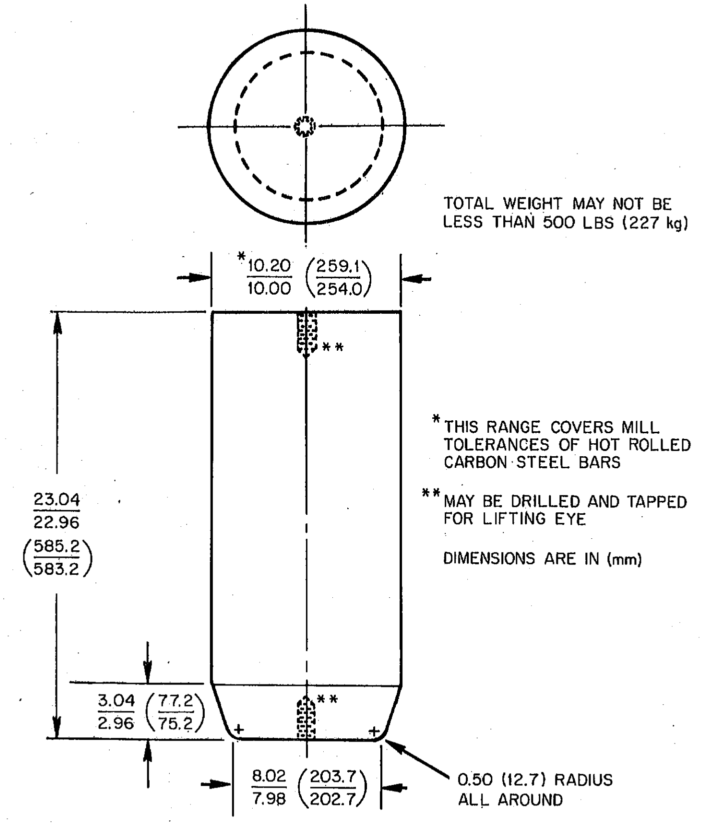
TOTAL WEIGHT MAY NOT BE LESS THAN 500 LBS (227 kg)
*10.20/10.00 (259.1/254.0)
**
23.04/22.96 (585.2/583.2)
*THIS RANGE COVERS MILL TOLERANCES OF HOT ROLLED CARBON STEEL BARS
**MAY BE DRILLED AND TAPPED FOR LIFTING EYE
DIMENSIONS ARE IN (mm)
3.04/2.96 (77.2/75.2)
**
8.02/7.98 (203.7/202.7)
0.50 (12.7) RADIUS ALL AROUND

FIG. 1

placed on top of the FOPS (small end of the object down) at the location designated in paragraph 5.2.

5.2 The small end of the object is to be entirely within the vertical projection of the critical zone (SAE J397), in that zone's upright position, on the FOPS top.

5.2.1 Case 1—When major, upper, horizontal members of FOPS do not enter the projection of the zone on the top. The center of the drop object shall be at that point which has the greatest possible sum of perpendicular distances (X + Y in Fig. 2) from major, upper, horizontal structural members.

5.2.2 Case 2—When major, upper, horizontal members do enter the projection of the zone on the top. The center of the drop object shall be in the segment of greatest area. Area is projected area of zone without major, upper, horizontal members. The center of the drop object shall be at that point, within the segment of greatest area, which has the greatest possible sum of perpendicular distances (X + Y in Fig. 2) from major, upper, horizontal structural members.

5.3 The object is to be raised vertically 17 ft (5.19 m) above the position indicated in paragraphs 5.1 and 5.2.

5.4 The object is to be released so that it falls without effective restraint onto the FOPS.

5.5 As it is unlikely that the free fall will result in the object hitting at the location and/or in the attitude of paragraphs 5.1 and 5.2, the following limits are placed on deviations.

5.5.1 The initial impact of the small end of the object shall be entirely within a circle of 8 in (200 mm) radius. (The center of this circle is to coincide with the vertical centerline of the weight as positioned per paragraphs 5.1 and 5.2, but not on any major, upper, horizontal member.)

5.5.2 The first contact between the object and the FOPS shall be only along the small end of the object and/or the radius contiguous to that end (Fig. 1).

5.5.3 There is no limitation on location or attitude of subsequent impacts.

6. Performance Requirements

6.1 The critical zone (SAE J397) shall not be entered by any deflection of the FOPS under the first or any subsequent impacts of the drop test object.

6.2 The FOPS shall also meet the applicable minimum performance criteria for rollover protective structure (SAE J320, J394, J395, or J396). (Identical, but not necessarily the same, structures are to be used for the FOPS and ROPS evaluations. Should the same structure be used for both evaluations, the drop test procedure shall precede the ROPS loading with removal of impact dents or replacement of the FOPS cover permissible.)

6.3 The drop test shall be performed with all ROPS and FOPS members at 0 F, or below, or the material used in the FOPS cover shall exhibit either of the following Charpy V notch impact strengths:

Standard specimen: 8 ft-lb at −20 F (10.8 J at −28.8 C).
10 mm × 5 mm specimen: 5 ft-lb at −50 F (6.8 J at −45.6 C).

Reference: ASTM A 370-68, Standard Methods and Definitions for Mechanical Testing of Steel Products.

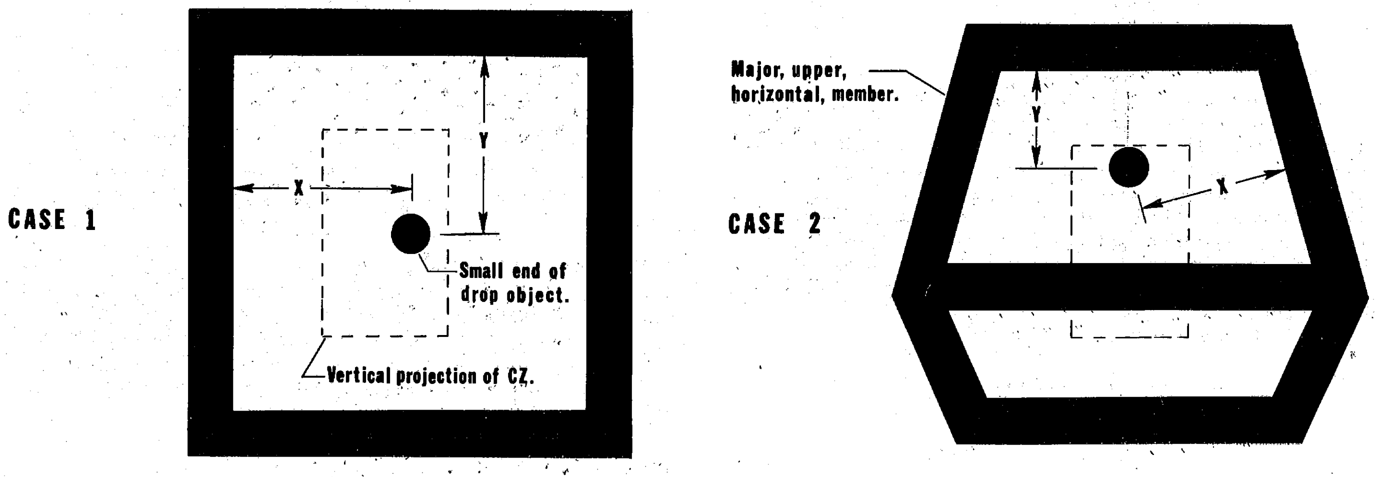
CASE 1
X
Y
Small end of drop object.
Vertical projection of CZ.
CASE 2
Major, upper, horizontal, member.
Y
X

FIG. 2